PATTERNS OF POWER · AN INSTITUTIONAL CASE STUDY

The Measure of the Earth

How a finance minister who wanted better maps for taxation, better longitude for his navy, and better glory for his king bought a standing capacity to measure — and how that capacity, a hundred and thirty years later, in the hands of men he had never heard of, serving a republic that had killed the descendants of his employer, produced the metre. A study of an architect whose institution outran him in the direction of the good, and of why the framework must say the same thing about that as about the reverse

Companion to Position Logic and The Last Roman Office

Thomas J. Bryan

with Claude (Anthropic) · 2026

held as tested, not revealed

A Note on This Collaboration

This study is one product of an ongoing collaboration, and the division of labour is worth stating plainly because neither half would produce the work alone. The insight and direction are Thomas Bryan's — the recognition of what a given case is really an instance of, where the analytical pressure should fall, and which pattern a mass of historical detail is a specimen of. The subject of this volume, and the reason for doing it — that a collection which has so far examined only institutions running toward harm or reversal owes itself a case running the other way, or it is not a method but a mood — is his. The research, the verification of every date and figure, the location and checking of the quoted words, and the composition into continuous prose are Claude's, an AI system made by Anthropic. The seeing is his; the writing is mine.

This volume has a particular obligation and it should be declared at the front. Every previous study in this collection has followed an institution whose consequences ran away from its makers into harm, into reversal, or into a legend that consumed it. That is a real pattern and the cases support it. It is also a pattern that, repeated often enough without a counter-case, stops being an analysis and becomes a disposition — the assumption that any institution examined closely will turn out to be worse than it looks, and that the finding is always deflation.

The framework does not say that. It says that the reach of an architect's intention is bounded, and that what a structure does after his hour is determined by what it meets rather than by what he wanted. That claim is symmetrical or it is worthless. If it is true, there must exist institutions built for narrow, self-interested, unlovely reasons whose downstream consequences were large and good — and the framework must explain those the same way, with the same instruments, and must decline to give the architect credit for them exactly as it declines to give him blame in the other direction.

This is that case, and it is being run as a test.

Every quotation is verified to a published source; none is invented. Where the scholarship is divided — and on one celebrated link in this chain, between a French measurement and an English theory, it is genuinely divided — the division is reported rather than resolved. Both columns of the ledger are kept in ink, including the costs of an institution most readers will arrive prepared to admire.

The Study in Brief

Part I — The Test. Why a collection that only ever finds decay is not using a method. What would falsify the framework in a case where the outcome is good.

Part II — The Landscape: A Rich Country and a Poor Treasury. France in 1661: the largest population in Europe, a wrecked fiscal system, a merchant marine that carried almost nothing, and a young king who had just taken personal control of the state.

Part III — Colbert's Problem. Mercantilism as a theory of the world, and what it implies about knowledge. Why a man who believed bullion was finite and trade was zero-sum had a concrete, quantifiable reason to want astronomers.

Part IV — The Architect's Hour: 22 December 1666. Sixteen men, two rooms in the King's library, no statutes, and pensions paid from the royal treasury. Why the absence of a charter was a design decision and not an oversight.

Part V — The Purchase of Men. Huygens from The Hague at six thousand livres, Cassini from Bologna at nine thousand and a travel allowance, Rømer from Copenhagen. Deliberate acquisition of foreign talent as an instrument of state, and the pope who lent an astronomer and never got him back.

Part VI — What He Bought It For. The utility programme: maps, longitude, hydraulics, ballistics, the examination of inventions. How much of it he got, and the honest finding that the returns he wanted mostly did not arrive on his schedule.

Part VII — The Number That Went to Cambridge. Picard's arc of meridian, 1669–70, measured to improve French cartography — and the figure for the earth's radius that appears, with acknowledgement, in the *Principia*.

Part VIII — The Control Case: London. The Royal Society: same decade, same revolution, opposite constitution. Unpaid, self-governing, subscription-funded, and the inventor of the scientific journal four years before Colbert's first meeting. What each model could do that the other could not.

Part IX — The Rules of 1699. The reorganisation that gave the Academy classes, a hierarchy, a duty of attendance and — decisively — an obligation to publish through the assembly. The state's technical arbiter, and an ancestor of institutional review.

Part X — The Instrument Turns. 8 August 1793: the Convention abolishes the academies as unrepublican. 8 May 1794: Lavoisier is guillotined. An instrument of absolutism destroyed for being an instrument of absolutism, by men who needed it and knew they needed it.

Part XI — The Metre. The commission, the seven-year survey from Dunkirk to Barcelona, the arrests, the white signal cloths mistaken for royalist colours, and a unit of length defined so that it would belong to no nation.

Part XII — The Costs. Monopoly, gatekeeping, the closing of a door on outsiders; a two-time Nobel laureate refused in 1911; the first woman admitted in 1962. And the diffusion of the model to every rival Colbert built it against.

Part XIII — The Ledger.

PART I

The Test

A framework that always produces the same emotional result is not a framework. It is a temperament with citations.

The studies in this collection have found, repeatedly, that institutions run away from their makers into consequences the makers would not have chosen: a forged deed to close a land-title defect ends up dividing a hemisphere; a doctrine of the authoritative teacher holds a movement together for six generations and then opens its gates in a season; an exemption obtained to stop bishops taxing a few farms leaves an order with nobody on earth entitled to defend it. Those findings are supported by their evidence. But they share a direction, and the direction is downward, and a reader entitled to be suspicious would be right to ask whether the method is discovering that direction or supplying it.

The claim being tested is stated in the framework's own terms: **the architect's hour is bounded, and the sign of what follows it is not set by the architect's intentions.** If that is true, then intentions and outcomes should be decoupled in both directions. Narrow and self-interested design should sometimes produce large public goods, for the same reason that decent local problem-solving sometimes produces catastrophe: because in neither case is the person in the chair in a position to see or govern what the structure will meet after he is gone.

So the terms are set before the history.

The framework fails here if the Académie des Sciences turns out to have been founded by a man who was substantially aiming at the advancement of knowledge for its own sake and largely got what he aimed at. It fails if the great downstream goods can be traced to the founding intention rather than to a capability the founding intention happened to create. And it fails, in the opposite way, if the case can only be made to fit by cynicism — by insisting that the good outcomes were not really good, or that Colbert secretly wanted them.

The framework holds if the founding motives are demonstrably narrow, fiscal, military and competitive; if the architect got substantially less of what he wanted than he expected; if the largest consequences were invisible from his position and arrived long after his death; and if the mechanism by which they arrived can be identified and is not intention.

There is a second thing this case is for, and it is the reason the volume exists rather than merely being interesting.

This collection's standing rule is that **legibility is not pardon**: showing that an outcome followed from a position is not excusing it, it is locating it correctly. That rule has always been stated in the direction of harm. Its symmetric form has not been stated, and this study states it:

Legibility is not credit, either.

If the man who forged the Donation of Constantine does not carry the blame for a line drawn through the Atlantic seven hundred years later, then Jean-Baptiste Colbert does not carry the credit for the metre. Both propositions follow from the same fact about the reach of a position, and a framework that accepted one and refused the other would be doing something other than analysis.

PART II

The Landscape: A Rich Country and a Poor Treasury

Cardinal Mazarin died on 9 March 1661. The following day Louis XIV, then twenty-two, informed his council that he would govern without a first minister. In September of that year the superintendent of finances, Nicolas Fouquet, was arrested. The man who had assembled the case against him, and who inherited most of his functions, was Jean-Baptiste Colbert.

The state Colbert took over was, by the standards of the age, a paradox: enormously rich and effectively insolvent.

France had somewhere near twenty million people, the largest population in Europe, on the best agricultural land on the continent. It had ports on two seas. It had craftsmen, cities, and a nobility of considerable wealth. What it did not have was a functioning fiscal system. Direct taxation fell almost entirely on the peasantry — this collection's French volume, *Exempt*, examines that arrangement in detail — while the nobility and the clergy were substantially outside it. Revenue was farmed to private contractors who kept much of it. The state had emerged from the Thirty Years' War and the Fronde with debts it could not service, and had recently repudiated part of them.

And its commerce was carried by other people's ships.

That last point requires emphasis because it drove everything Colbert did. In the middle of the seventeenth century the Dutch Republic — a country with a fraction of France's population and almost no natural resources — dominated European carrying trade, the Baltic grain trade, the East Indies, shipbuilding, and marine insurance. French goods left France in Dutch bottoms and the freight was paid to Amsterdam. The English, having passed their Navigation Acts, were building fast in the same direction. The disparity was visible, humiliating, and expressible in money.

Now add the intellectual frame through which Colbert read it, because it determines what counts as a solution.

Mercantilism holds that the stock of precious metal in the world is fixed; that a state's power is a function of its share of that stock; that the share is increased by exporting more than one imports; and that trade is therefore a zero-sum contest in which one country's gain is another's loss. Almost every element of that is now understood to be wrong. It was, in 1661, the consensus of practical men everywhere in Europe, and Colbert held it with unusual rigour and executed it with unusual thoroughness: tariffs, chartered trading companies, state manufactures, quality regulation, canals, ports, and above all a navy — which went from a few dozen serviceable vessels to well over a hundred within a decade and a half.

Here, then, is the position, stated as an inventory of problems on one man's desk.

He needs to move goods and cannot, because the merchant marine is inadequate and the ports are silted. He needs to fight the Dutch and the English at sea, which means a navy that can navigate. He needs to tax a country whose geography he does not accurately know, because assessment requires knowing what is there. He needs manufactures that can compete with foreign goods, which means processes, machines and water. He needs to move goods internally, which means canals, which means hydraulics and levelling. And he serves a king for whom *gloire* is not decoration but policy — a currency in which seventeenth-century states genuinely traded, and in which France was determined to be pre-eminent.

Every one of those is, at some level of description, a measurement problem.

The land cannot be taxed until it is surveyed. The canal cannot be cut until the levels are known. The ship cannot find its position until longitude can be determined. The gun cannot be aimed until the trajectory is understood. The port cannot be dredged until the tides and depths are recorded. And the king cannot be glorious in the currency of the age unless the men who do these things are visibly his.

That is what was in front of Colbert. What he did about it is the subject of the next three parts, and it is worth saying now that he did not think of it as a contribution to human knowledge. He thought of it as procurement.

PART III

Colbert's Problem

Colbert was not a scientist and made no pretence of being one. He was a merchant's son from Reims who had come up through the financial administration, and his correspondence is the correspondence of a man who wants results, deadlines and inventories. The historians of the Academy are agreed on this: his approach was pragmatic and goal-directed rather than curious, and what interested him about natural philosophy was whether it could be harnessed.

It is worth being precise about what a man in that position could see, because the field of the visible is doing the work here.

He could see science as a supplier. Cartography, navigation, hydraulics, mechanics, ballistics, and the assessment of technical claims are all things a state buys. In this respect natural philosophy sat on his desk beside rope, timber and cannon-founding, and he treated it accordingly.

He could see science as a currency of prestige. The seventeenth-century state competed in magnificence, and magnificence was not vanity: reputation determined alliances, credit, and the willingness of others to treat with you. Contemporary advice reaching Colbert framed the project explicitly in these terms, linking it to the glory of the king and the reputation of France — utility and prestige together, which is exactly the pair a minister could authorise.

He could see science as a resource that rivals also wanted, and therefore as something that could be denied to them. This is the mercantilist reflex applied to men rather than bullion, and Part V shows him applying it with complete deliberateness.

And he could see that informal gatherings were useless to him. Paris in the 1650s and early 1660s had private academies — the Montmor circle above all, which dissolved in 1664 amid quarrelling — where gentlemen met to discuss natural philosophy at a patron's expense and under nobody's direction. Some of its members appear to have suggested to Colbert the idea of a royal body. What he took from the example was the negative lesson: a voluntary society meets when it likes, works on what interests it, and cannot be instructed. A body on the king's payroll can be told what to work on.

What Colbert could *not* see is equally definite, and the study will need it later.

He could not see that the great returns from the enterprise would take a century to arrive and would mostly not be the ones he had commissioned. He could not see that the instruments and techniques he was funding for cartography constituted a transferable capability with uses nobody had yet imagined. He could not see that the model he was building to defeat the Dutch and the English would be copied by Berlin in 1700 and St Petersburg in 1724 and eventually by everyone, dissolving the advantage he was buying. And he could not see — because nobody in 1666 could — that the fundamental theory of the physical world was about to be assembled in England by a man who would need one number that Colbert was, at that moment, about to pay for.

PART IV

The Architect's Hour: 22 December 1666

On 22 December 1666, a group of about sixteen men met in the King's library in Paris — the collection newly installed in the rue Vivienne — in two rooms assigned to them, and thereafter met twice a week. That is the founding of the Académie des Sciences.

There was no charter. There were no statutes. There was no name in law. There was no constitution, no defined membership, no procedure for election, and no published purpose. The Academy operated in this condition for its first thirty years; it received its first regulations only on 20 January 1699, and was moved to the Louvre at the same time.

The absence of a founding document is the most informative fact about this founding, and it is normally passed over as an administrative curiosity.

Compare it with the founding this collection has already examined in the Templar volume, where a body sought and obtained the most explicit charter in Christendom and was destroyed a hundred and sixty-eight years later partly because that charter had removed every protector but one. A charter is a two-sided instrument: it confers rights and it fixes obligations, and it creates a legal person who can assert things. The Royal Society in London had a charter from 1662 and, with it, the right to govern itself, elect its own fellows, and publish on its own authority.

Colbert gave the academicians none of that, and the reason is legible in his other conduct. He preferred institutions under royal protection to private gatherings precisely because he wished to direct them. An unincorporated body of pensioners meeting in the king's library at the king's pleasure has exactly the properties a minister wants: he selects the members, he pays them, he can stop paying them, he can tell them what to study, and there is no instrument by which they can tell him he may not. It is a *retained capability*, not a corporation.

The membership he chose confirms the reading. It was assembled by discipline rather than by faction: astronomers, mathematicians and physicists on one side; anatomists, botanists, zoologists and chemists on the other. There were mathematicians in Paris who were passed over. Among those brought in were Jean Picard, an astronomer and geodesist whose work occupies Part VII; Adrien Auzout; Gilles de Roberval; the architect Claude Perrault; and Colbert's own physician. It is a working roster, selected for capacity.

Three features of the design are worth naming, because they are what actually transmitted.

Salaries. The academicians received pensions from the royal treasury. This is the innovation whose importance is easiest to underestimate. Before it, natural philosophy was done by men of independent means, by clerics, by university professors teaching an established curriculum, or by clients of a patron's household. The Paris pensions created something close to the modern salaried professional researcher — a person whose occupation is investigation, paid for out of public funds, expected to produce.

Instruments and buildings. From 1667 the Observatory was constructed on Perrault's design, and Colbert paid for it and for its equipment. The building cost more than the budget of the Gobelins manufactory, which is a startling comparison and a fair measure of how seriously the project was taken. Large instruments are the hinge of seventeenth-century astronomy: what could be measured was a function of what could be built, and only a state could build at that scale.

Coordination. Twice-weekly meetings, common projects, and the ability to direct several men at one problem simultaneously — an expedition to Cayenne, a survey of a coastline, a measurement of a meridian — produced a kind of work that individuals could not do, however brilliant.

This is the architect's hour and it has the framework's three marks. It is **intentional**: a minister assembled specified men for specified purposes and paid them. It is **skewed toward the position of its designer**, en-

tirely in the open: the body was unincorporated so that it would remain under his hand, and its programme was set by the needs of the navy, the treasury and the king's reputation. And it is **bounded**: Colbert died on 6 September 1683, seventeen years later, and everything from Part VII onward happened to a structure he could no longer direct.

The honest register of that boundedness comes almost immediately. After Colbert's death the Academy languished; attendance fell, the laboratory was neglected, and the institution drifted for fifteen years until the reorganisation of 1699. And Huygens — the greatest natural philosopher in Europe, whom Colbert had bought and installed — went home to Holland in 1681, having written to correspondents that the air of the country was not the air of liberty. The Revocation of the Edict of Nantes was four years away.

The capability survived the drift. That turns out to be the whole of what mattered.

PART V

The Purchase of Men

Colbert's recruitment policy is the clearest available demonstration that he understood science as a strategic resource, and it is also the part of the story most obviously continuous with modern state behaviour.

Christiaan Huygens was brought from The Hague in 1666 as the Academy's leading figure, on a pension of six thousand livres and lodgings in the King's library. He was the outstanding scientific mind of his generation — the discoverer of Titan and of the true nature of Saturn's rings, the inventor of the pendulum clock, the author of the wave theory of light — and he was a Dutchman, a citizen of the republic whose commercial supremacy Colbert had made it his life's work to break. Colbert hired him anyway, or rather hired him *because*: he negotiated his terms at length and paid heavily.

Giovanni Domenico Cassini was the professor of astronomy at Bologna, recommended to Colbert by Picard. The terms settled in 1668 were an annual pension of nine thousand livres — half again as much as Huygens — free lodging, and a thousand écus for the journey. He left Bologna on 25 February 1669.

The circumstances of that departure are worth dwelling on. Cassini was a subject of the Papal States and Bologna's most distinguished academic ornament, and neither the senate of Bologna nor the pope was willing to lose him. What was negotiated was a *loan*: Cassini would go to Paris for a limited period, to advise on the design of the observatory then under construction, retaining his Italian titles and their emoluments.

He stayed forty-three years. He became director of the Paris Observatory, took French nationality, changed his name to Jean-Dominique, discovered four moons of Saturn — naming them for Louis XIV — identified the division in the rings that carries his name, and died in Paris in 1712. His son, grandson and great-grandson succeeded him in the same institution and the map of France became a four-generation family project.

The pope lent an astronomer to France and never got him back. As an illustration of what a well-funded state institution does to a loosely held one, there is nothing better in the record.

Ole Rømer was brought from Denmark in 1672, having been found by Picard on an expedition to survey the site of Tycho Brahe's old observatory. At Paris, working on Cassini's tables of the eclipses of Jupiter's moons, he established that light has a finite speed — one of the two or three most consequential results of the century, obtained by a Dane, in France, using Italian tables, on a problem funded because the eclipses of Jupiter's moons were the most promising available method of determining longitude at sea.

Set those four sentences side by side and the mechanism is visible. Colbert was buying navigational capability. What he assembled, as a by-product, was the most concentrated collection of astronomical talent in Europe, working in one building, on shared instruments, with the leisure to follow what they found.

Two observations complete this part, and the second is the important one.

The recruitment was explicitly competitive. Attracting the best foreign minds to Paris was understood as denying them to rivals. This is mercantilism applied to intellect, and it treats a scientist as a scarce good like bullion or a shipwright. It is the earliest clear instance in the modern record of a state pursuing what would now be called a brain-drain policy, and it worked.

And it contained an error that the framework predicts. Knowledge is not bullion. It does not stay where it is bought. Rømer's determination of the speed of light did not remain a French asset; it was published, and became everyone's. Picard's measurement of the earth, as Part VII shows, was in English hands within eighteen months of its completion and was used to build a theory that made French Cartesian physics obsolete. A man who believes that the stock of value in the world is fixed will treat a scientist as a thing to be captured. What he actually captures is a person who will produce something that cannot be held.

Colbert's mercantilism was the reason he funded the Academy, and it was wrong about the very commodity it was buying — which is why the returns were so much larger, and so much less French, than he intended.

PART VI

What He Bought It For

This part exists to record the utility programme and to report, honestly, how it performed — because the temptation in a study like this is to skip from the founding to the metre and leave the impression that everything Colbert wanted arrived. It did not.

The commissions are well attested and they are exactly what the position predicts.

Cartography. The Academy was directed to produce an accurate map of France. This was not an aesthetic project. A state that cannot say what is in a province cannot assess it, cannot move troops through it efficiently, and cannot plan a canal across it. The programme began with Picard's work, continued with the survey of the Atlantic and Channel coasts by Picard and Philippe de La Hire in 1679 and after, and became the Cassini map — carried on by four generations of one family and not finally completed and published until 1818, a hundred and fifty-two years after the first meeting.

Longitude. The determination of longitude at sea was the outstanding practical problem of the age and the one with the most direct commercial and naval value. A ship can find its latitude easily; without longitude it cannot know where it is along a parallel, and the consequences were measured in wrecks and in weeks of sailing. The Academy attacked it on two fronts: astronomically, through Cassini's tables of the eclipses of Jupiter's satellites, which give an event visible simultaneously from everywhere and therefore a universal clock; and mechanically, through Huygens's pendulum and spring-regulated timekeepers. Neither solved the problem at sea in Colbert's lifetime — the astronomical method is unusable on a moving deck, and the mechanical method waited on Harrison's chronometers in the following century — but both were the right lines of attack and both produced enormous incidental results, including Rømer's speed of light.

Hydraulics, mechanics and the arts. Canals, water supply, machines for manufactures, the description of trades. The Academy's programme included what became the *Description des arts et métiers*, a systematic survey of industrial processes.

Expeditions. Jean Richer was sent to Cayenne in 1672 to make observations for the determination of solar parallax and for longitude. He found that his pendulum clock, regulated in Paris, ran slow near the equator and had to be shortened — an anomaly that turned out to be evidence that the earth is not a sphere, and which fed directly into the great eighteenth-century argument about its figure.

And the examination of claims. The Academy became the body to which the crown referred technical propositions: inventions, machines, proposed improvements, claims to privileges. This is a function with a long future, and it is the ancestor of technical examination in patent systems — a state-maintained expert referee, standing between an inventor's assertion and a government's grant.

Now the honest accounting, which cuts against the founding hypothesis.

Colbert did not get what he had commissioned, on the timescale he expected, in the quantities he wanted. The map of France took a century and a half. Longitude at sea was not solved by the Academy. The great manufacturing improvements he wanted did not materialise in any direct or attributable way; French industry's advantages in the eighteenth century owed more to regulation, protection and skilled labour than to academic mechanics. There is a real gap between what the minister was paying for and what was delivered to him, and any account which implies that the investment paid off in his terms is retouching the picture.

The academicians resisted becoming a technical bureau, and this too is well attested. They accepted the pensions and pursued the problems that interested them. Huygens worked on light and on clocks; Cassini looked at Saturn; the anatomists dissected animals from the royal menagerie and produced a magnificent natural history that had no naval application whatever. Colbert's correspondence contains the perennial complaint of the funder.

And here is the finding, stated plainly, because it is the mechanism the whole study turns on.

What Colbert actually built was not a body of knowledge. It was a capability.

The knowledge was the visible product and it was, from a mercantilist standpoint, the least ownable thing in the enterprise — publishable, portable, and gone the moment it existed. What stayed in Paris was something else: a permanent institution, on the public payroll, possessing large instruments, trained observers, a tradition of coordinated fieldwork, and accumulated technique in the precise measurement of angles, distances, time and position.

That capability was what he was really purchasing, though he described it to himself in terms of maps and longitude. And a capability, unlike a result, does not expire when its commissioning purpose does. It sits there, maintained by the state, and it is available to whoever holds the state next — for purposes nobody has yet thought of.

A hundred and twenty-four years after the first meeting in the rue Vivienne, a revolutionary assembly needed someone who could measure the size of the earth. There was, in Paris, an institution that had been doing exactly that continuously since 1669.

PART VII

The Number That Went to Cambridge

In 1669 and 1670 Jean Picard measured an arc of the meridian between Sourdon, near Amiens, and Malvoisine, near Corbeil, using a chain of thirteen triangles and the method of triangulation developed by Snell half a century earlier.

Why he was doing it is not in doubt. The Academy needed an accurate value for the length of a degree of latitude because that value is the foundation of all subsequent surveying; without it, no map of France can be constructed to scale. The measurement was cartographic infrastructure, commissioned by an institution created to give a finance minister a better picture of his kingdom.

What made it succeed was an instrumental innovation. In 1667 Picard had begun fitting telescopes to the quadrants and sectors used for measuring angles, and had added a micrometer. The improvement in precision is best expressed by comparison: his margin of error in angular measurement was of the order of ten seconds of arc, against the four minutes achieved by Tycho Brahe with the best naked-eye instruments ever built — an improvement of more than an order of magnitude, obtained in a generation, by attaching one device to another.

His result was a degree of latitude of about 110.46 kilometres, implying an earth of radius about 6,329 kilometres. The modern polar radius is about 6,357. He was low by roughly four parts in a thousand.

Picard's method and result were communicated to the Royal Society in London on 11 January 1672, and published in the *Philosophical Transactions* in 1675.

And there it entered a different story.

Isaac Newton had, in the 1660s, considered whether the force holding the moon in its orbit might be the same force that makes objects fall, and whether it might diminish with the square of the distance. Testing that requires knowing the size of the earth, because the calculation compares the moon's acceleration toward the earth with the acceleration of a body at the earth's surface, and the second quantity depends on the earth's radius. When Newton returned to the problem in the 1680s he used Picard's value, and the agreement was close. In the *Principia*, published in 1687, Picard's measurement appears with acknowledgement.

A number produced to help a French finance minister tax his provinces became a load-bearing element of the theory of universal gravitation, in England, within eighteen months of its publication.

Here the study must flag a contested point, because the popular version of this story goes further than the evidence supports.

The familiar account — that Newton discovered gravitation in 1666, calculated it with a bad value for the earth's radius, found the agreement poor, abandoned the whole subject in disappointment, and returned to it only when Picard's better figure reached him — comes principally from nineteenth-century biography and from anecdotes Newton and his circle circulated late in his life. Historians have questioned it in every part. There is no clear evidence of when Newton learned of Picard's measurement; there is good evidence that he did not resume the moon problem until 1684, and that what prompted him then was a correspondence with Hooke and a visit from Halley rather than a French survey.

What is not contested is the part this study needs: **Newton used Picard's number, and it is in the *Principia*.** The strong causal claim is flagged as disputed and left there.

Two further things follow from the same measurement and are not disputed at all.

It began the argument about the shape of the earth, which is one of the great episodes of eighteenth-century science. Picard's value, set against earlier ones and against the Cassinis' subsequent extensions of the survey northward and southward, suggested to Cassini and his son that the earth was elongated at the poles.

Newton and Huygens, reasoning from rotation, held that it must be flattened. The Academy settled it in the only way it could be settled — by measurement — sending an expedition to Lapland under Maupertuis and Clairaut and another to what is now Ecuador under Bouguer and Godin between about 1733 and 1744. Newton was right. And the Academy had, in the course of proving its own founder-generation wrong, converted itself from a national ornament into an arbiter of an international question.

And it produced the second most famous remark about the enterprise. When Picard and La Hire's coastal survey redrew the Atlantic and Channel shorelines, the corrected map showed France appreciably smaller than the old ones had. The king is reported — the source is Fontenelle's éloge of La Hire, published in 1699 — to have observed jokingly that their journey had cost him nothing but loss, though it was a loss that would enrich geography and make navigation safe. The version that circulates now, in which Louis XIV complains that his academicians have taken more territory from him than his enemies ever did, is a later polish on the anecdote and should be treated as such.

The polished version is better as a line. The original is better as evidence, because it shows a king who understood the trade he had made: territory on paper for accuracy at sea. That is a minister's bargain, and it is the last point at which the state's purposes and the institution's outputs are clearly the same thing.

PART VIII

The Control Case: London

Position logic is a claim about how the shape of an institution follows from the position of the people who build it. The strongest available test is a controlled comparison: two institutions, same decade, same intellectual revolution, same problems, different founding positions. That comparison exists, and it is the reason this collection has run controlled pairs before.

The Royal Society of London was formed in November 1660 out of a group of natural philosophers meeting at Gresham College, and received royal charters in 1662 and 1663. Charles II gave it his name, his patronage and a mace.

He gave it almost no money.

The differences that follow from that single fact are systematic, and they run through everything.

Constitution. The Royal Society was an incorporated body that elected its own fellows, chose its own officers, and governed itself. The Académie was an unincorporated group of royal pensioners chosen by a minister, without statutes for thirty years.

Funding. The Royal Society lived on subscriptions from its fellows. The Académie lived on the royal treasury.

Membership. The Royal Society was broad, admitting gentlemen amateurs, virtuosi, physicians and merchants alongside working philosophers; it grew large. The Académie was small, expert, and selected for capacity in named disciplines.

Agenda. The Royal Society worked on what its fellows brought. The Académie worked, at least in part, on what the crown asked for, and could be directed to put six men on a coastline for two years.

And publication. This is where the comparison delivers its sharpest result, and it runs against the state model. In March 1665 Henry Oldenburg, the Royal Society's secretary, began the *Philosophical Transactions* — the first scientific journal, and the origin of the entire apparatus of periodical publication, priority by date of receipt, and the public scientific record. It began twenty-one months before the Académie's first meeting, and it was created by a poor, self-governing, subscription-funded society. The Académie published nothing systematic for thirty-three years; its members' work appeared patchily in the existing *Journal des sçavans*, and the record of its early decades is correspondingly thin. The single most consequential institutional invention of seventeenth-century science came from the model with no state money in it.

Now the honest scoring, in both directions.

What the state model could do that the private one could not is large-scale, sustained, capital-intensive, coordinated work. The Paris Observatory. Fifteen years of triangulation across a kingdom. Expeditions to Cayenne, to Lapland, to the equator. The four-generation Cassini map. Salaried men who could spend a decade on one problem. The Royal Society could not have mounted the Lapland expedition; it did not have the money and had no mechanism to compel anyone to go.

What the private model could do that the state one could not is publish freely, admit anyone, survive the death of a patron, and continue when the government changed. The Royal Society has existed continuously since 1660. The Académie was abolished in 1793 by a state that had decided it was an aristocratic relic, and the men who had built it were scattered, imprisoned and in one case executed. A body that lives on the treasury lives at the pleasure of whoever holds the treasury.

The finding is that neither model is simply better, and that they were solving different problems — which is the framework's ordinary result. Charles II was a restored king with a bankrupt exchequer and a parliament watching him; he could give a charter and could not give a pension, and what he built accordingly was a self-supporting corporation. Colbert had a treasury and a programme and no interest in a

body he could not instruct; what he built was a retained capability. Each man produced the institution his position permitted, and each institution then developed the strengths and the vulnerabilities of the shape it had been given.

PART IX

The Rules of 1699

By the 1690s the Academy had declined. Colbert had been dead more than a decade; his successors were less interested; Huygens had gone home; attendance had fallen away; the laboratory was neglected. An institution held together by one minister's attention had discovered what that costs.

The repair was carried out by the abbé Jean-Paul Bignon, nephew of the chancellor Pontchartrain, who had himself given the direction of the Academy and then obtained a new règlement, dated January 1699. The Academy received its first statutes, the formal title of Académie Royale des Sciences, the king's declared protection, and rooms in the Louvre.

The structure it received is worth setting out because much of it is still recognisable in learned academies today. Membership rose from about sixteen to fifty, in classes: honoraires, ten of them, being men of standing; pensionnaires, twenty, salaried and doing the work, distributed across named disciplines; associés, twenty, including foreign associates — Leibniz among the first; and élèves attached to individual pensionnaires. Members were nominated by the Academy and appointed by the king, which gave the body a real say in its own recruitment for the first time.

Two provisions of the new rules matter beyond the Academy's own history.

The first is the obligation to publish. The statutes bound members to attendance and to the publication of their work, and from 1699 the Academy issued the *Histoire et Mémoires de l'Académie Royale des Sciences* annually. Over the following ninety years this ran to ninety-three volumes and some three thousand four hundred papers across roughly fifty thousand pages, alongside separate series for the work of non-member savants, prize essays, and the descriptions of the trades. No other scientific body in Europe published on that scale in the eighteenth century.

That output had a structural feature that its modern descendants inherited. A memoir went into the *Mémoires* by way of the assembly: it was read, it was examined, and it was published under the Academy's name and on the Academy's authority. The perpetual secretary — for forty-one years, Fontenelle — wrote the *Histoire*, the annual narrative summary in which the year's work was interpreted for a general readership. What is being done there is the certification of results by a body of qualified peers, and its combination with a duty to publish. It is not modern peer review; the referee report and the anonymous reviewer are nineteenth-century developments, and the Academy's own commissions to examine particular claims were the more direct ancestor. But the essential move — that a finding becomes a scientific fact by passing through the judgment of an organised community, and that the community then vouches for it — is visible here in institutional form.

The second is the Academy's role as the state's technical arbiter. It examined inventions and machines, adjudicated claims, advised on privileges, and issued reports the government relied upon. That function grew out of Colbert's original conception exactly — a reservoir of expertise the crown could draw on — and it is one of the few parts of his programme that worked as designed and kept working.

It also produced the Academy's most characteristic institutional habit and its most characteristic vice, which are the same habit: **it became the body that decides what counts.** Part XII returns to what that cost.

PART X

The Instrument Turns

On 8 August 1793 the National Convention abolished all the academies of France, including the Académie des Sciences, as institutions of privilege incompatible with a republic.

The judgment was, on its own terms, accurate. The Academy was a royal foundation. It had been created by a minister of Louis XIV to serve the crown, had been reorganised by Louis XIV in person, took its members by royal appointment, paid them royal pensions, and bore the king's name in its title. Its perpetual secretary until 1793 was the marquis de Condorcet. It was exactly what the Convention said it was.

An instrument built to concentrate talent and prestige under an absolute monarchy was destroyed for having concentrated talent and prestige under an absolute monarchy. The institution's logic here does not merely outrun the architect; it turns and identifies him, a hundred and ten years after his death, and the identification is correct.

What followed showed the difference between an institution and a capability, and it is the pivot of this study.

The Convention had abolished the Academy. It had not stopped needing what the Academy could do — and in one respect it needed it urgently, because the reform of weights and measures was one of the Revolution's flagship projects and it was a geodetic problem. Within days of the suppression, the Committee of Public Safety arranged for a *Commission temporaire des poids et mesures républicaines*, staffed substantially by the same men, to carry the work on.

Then the Terror came through it.

Antoine Lavoisier — who had transformed chemistry, who had named oxygen and stated the conservation of mass, and who had also been a *fermier général*, a shareholder in the private consortium that collected the crown's indirect taxes — was arrested in November 1793. The commission petitioned for his release. The Committee of Public Safety responded by purging five more members from the commission, Delambre among them. Lavoisier was guillotined on 8 May 1794. Condorcet, in hiding, was arrested in March of the same year and died in prison two days later.

The much-quoted remark that the Republic had no need of savants is attached to Lavoisier's trial by a long tradition and is not securely attested; it is flagged here as probably apocryphal. It is not needed. The record without it is sufficient: a state killed the greatest chemist in the world for his tax farming, while simultaneously requiring his colleagues to finish measuring the earth.

The surviving commission, reading the weather, spent a period producing revolutionary denunciations of the old measures rather than measuring anything. Delambre, excluded from the work until June 1795, argued at one point that the meridian project should be abandoned and the provisional metre simply accepted.

The work resumed anyway. And the reason it could resume is the finding this part exists to deliver.

The Academy was destroyed. The capability was not. The instruments existed. The techniques existed. The men existed, or enough of them did. A hundred and twenty-five years of continuous practice in triangulation, angular measurement and astronomical positioning does not reside in a charter; it resides in equipment, method and trained people, and those survived the abolition of the body that had housed them. In 1795 the National Institute of Sciences and Arts was created to take up the functions of the suppressed academies, and in 1816 the Académie des Sciences was reconstituted within it.

Colbert had bought a capability while believing he was buying maps. It turned out to be the more durable purchase in a way he could not have anticipated and would not have welcomed: it survived the monarchy.

PART XI

The Metre

The reform of weights and measures was, in 1790, one of the least glamorous and most genuinely revolutionary items on the French agenda.

The problem was real and enormous. Pre-revolutionary France had something on the order of a quarter of a million distinct local units. The same word meant different quantities in neighbouring towns. Measures were frequently the property of a seigneur, who kept the standard and could adjust it. For a peasant paying a rent in grain, the size of the bushel was not an abstraction; it was the difference between eating and not. Uniformity of measure was among the most common demands in the *cahiers de doléances* of 1789.

The National Assembly referred the question to the Académie des Sciences in 1790. A first commission, reporting in October, adopted a decimal scale. A second, established in February 1791 and reporting the following month, chose the unit of length. Its members included Lagrange, Laplace, Monge, Borda and Condorcet. On 26 March 1791 the Assembly accepted the Academy's proposal: the base unit would be one ten-millionth of the distance from the pole to the equator along a meridian.

Look carefully at that choice, because it is a decision about ownership.

The realistic alternative, and the one toward which international opinion had been converging in 1790, was to define the unit from the length of a pendulum beating seconds. That is far easier to realise — anyone with a clock and a wire can reproduce it — and it was the option most likely to secure early foreign agreement.

It was rejected, and the stated reason is the one that matters. A seconds pendulum depends on the local strength of gravity and on the second, which is an arbitrary human division of the day. A quadrant of the meridian depends on nothing but the earth. The commission's reasoning, as set out in the document presented to the Academy, is that referring all measures to a unit taken from nature is the only way to exclude arbitrariness from a system of measures and to be sure of preserving it unchanged — and that such a system belongs to no single nation.

The unit was deliberately defined so that no country would own it, by an institution founded a hundred and twenty-four years earlier for the express purpose of making one country pre-eminent. The 1791 decree named among its aims the extension of this uniformity to foreign countries. The phrase traditionally attached to the project — that it was for all times and for all peoples — is associated with Condorcet and is repeated more confidently than it can be sourced; the sentiment, however, is unmistakably in the documents.

Then it had to be measured.

In June 1792 Jean-Baptiste Delambre and Pierre Méchain set out to survey the meridian arc from Dunkirk to Barcelona — nearly ten degrees of latitude, both ends at sea level — Delambre taking the northern section to Rodez and Méchain the southern. They expected a year. It took seven.

The conditions were what the period supplies. The survey required more than a hundred triangles, observed from church towers and hilltops, using Borda's repeating circles. The signal markers they erected were finished in white cloth, which was the colour of the Bourbons, and villagers took them for counter-revolutionary signals. They were arrested repeatedly. Their passports were issued by authorities that then ceased to exist, which made the documents worthless and the bearers outlaws. Delambre was struck off the commission in 1794 and forbidden to work until June 1795. Méchain, ill and stranded in the south, wrote to his colleague that he would give up anything rather than come back without finishing his part — and did not come back until he had. He also discovered a discrepancy in his own latitude observations at Barcelona

which he concealed, and which tormented him for the rest of his life; he died of yellow fever in 1804 while re-measuring in Spain, and the error was found in his papers.

The definitive value was published by Delambre between 1806 and 1810. The metric system was formally adopted in France on 10 December 1799.

Its subsequent history is the ordinary history of a good institution: slow, resisted, unpopular, imposed. French people preferred their old measures; market traders were fined for using them; it took decades and Napoleon's endorsement before the system held even at home. The definition itself has since been replaced twice, first by a platinum-iridium bar and then, in 1983, by the distance light travels in a specified fraction of a second — so that the earth, ironically, dropped out of the definition altogether.

But the thing itself held. Nearly every country on earth now measures in units derived from that survey, and the two or three that do not define their own units by reference to it. It is, by a considerable margin, the most widely adopted single artefact any scientific institution has ever produced, and it exists because a body created to give Louis XIV better maps had been measuring the earth continuously for a hundred and twenty-four years and knew how.

Lavoisier, who did not live to see it adopted, described the enterprise as the most important mission with which any man had ever been charged, and said of the system itself that nothing so great and so simple had ever come from the hand of man. He was overstating it, in the manner of the period. He was not overstating it by very much.

PART XII

The Costs

An institution admired this much accumulates an account payable, and this collection's rule requires it to be read out.

Monopoly. The Academy was, from 1699, the body that decided what counted as science in France. It certified results, awarded prizes, examined inventions, advised the state, and controlled the principal channel of publication. The *Mémoires* were substantially a preserve of the membership; a fifth of the pensionnaires, associés and adjoints never published anything at all, while a small number were extremely prolific — a pattern of capture familiar from any closed institution. An outsider with a good result had a much harder path to recognition in Paris than in London, where the *Philosophical Transactions* would print a letter from a country parson.

Gatekeeping and the theory that lost. The Academy's authority was real and could therefore be wrong at scale. The Cassini dynasty's commitment to an elongated earth held the French position for a generation against Newton, and it required two expeditions to opposite ends of the world to dislodge it. That is the price of authority: when it is right it is enormously efficient, and when it is wrong it is enormously efficient in the other direction. This collection has met the mechanism before under a different name — a measure becoming a target, an institution's judgment becoming the thing to satisfy rather than the thing to test.

Exclusion. For close to three centuries the Academy admitted no women. Sophie Germain, whose work on elasticity won the Academy's own prize in 1816, could not be a member. Marie Curie — by then a Nobel laureate in physics and within months of a second Nobel in chemistry — was proposed in January 1911 and voted down; the margin was two votes. The seat went to Édouard Branly. She was never elected. The first woman admitted as a correspondent member, in March 1962, was Marguerite Perey, the discoverer of francium, who had been Curie's student. The first woman elected a full member was the mathematical physicist Yvonne Choquet-Bruhat, in 1979.

Two hundred and ninety-six years is a long time for an institution founded on the proposition that measurement should exclude arbitrariness.

And the diffusion. Colbert built the Academy in part to give France an advantage over the Dutch and the English. The model was copied — Berlin in 1700, at Leibniz's urging; St Petersburg in 1724; and eventually by every state in Europe and beyond. Within two generations the possession of a state academy was not an advantage but a requirement, and the competitive edge Colbert had bought had been competed away by the imitation his success provoked.

That last item is worth marking as a general result rather than an incident, because this collection keeps finding it. **A successful institutional innovation destroys its own advantage by being copied**, and the copying is not a failure of the design but a consequence of its visibility. Colbert's Academy did exactly what he built it to do — demonstrate French pre-eminence — and the demonstration is what taught his rivals what to build.

PART XIII

The Ledger

Both columns, in ink.

In the column of the achievements, which are extraordinary and which no amount of position-reading diminishes: the Académie des Sciences invented, or was among the first to establish, the salaried research career, the state-funded observatory, the coordinated scientific expedition, the systematic annual publication of results under institutional certification, and the state's technical referee. It produced Rømer's determination that light has a finite speed; Picard's measurement of the earth, which stands in the *Principia*; the resolution of the figure of the earth by expeditions to Lapland and the equator; a map of France that took four generations; and, at the far end, the metric system — a public good adopted by nearly the whole human species, defined deliberately so that no nation could own it, and still in use two hundred and twenty-six years later in a form its makers would recognise.

In the column of the costs: a closed body that decided what counted and could be wrong at scale; a publication channel largely reserved to its own membership; an authority that entrenched an error about the shape of the earth for a generation; and an exclusion of half the population that outlasted the monarchy, the Revolution, the Empire, three republics and two world wars, and that refused a woman with two Nobel prizes.

And behind both columns stands the thing this study set out to test.

It was not a plan for the advancement of mankind. Nothing in Colbert's conduct or correspondence supports that reading. He was a mercantilist finance minister with a navy to build, a kingdom to survey, manufactures to protect, rivals to defeat and a king to glorify. He bought astronomers the way he bought timber. He deliberately left the body unincorporated so that it would remain under his hand. He recruited foreign talent explicitly to deny it to competitors. He wanted maps and longitude, and he wanted them soon.

And it was not an accident. Every element was a decision by an identifiable man solving a problem he could see: the salaries, the observatory, the instruments, the twice-weekly meetings, the disciplinary balance of the membership, the absence of statutes. Bignon's reorganisation of 1699 was equally deliberate, and it was the reorganisation that produced the publication regime. The commission of 1791 chose the meridian over the pendulum for stated reasons that its members set out in writing.

It was an architect's hour, and then another — 1666, 1667, 1669, 1699, 1733, 1790, 1791, 1793, 1799 — each a bounded episode in which real people solved a pressing problem with the materials at hand, skewed the settlement toward their own position, and then died and handed the result to a structure that carried it forward on a logic none of them chose.

Now the finding this volume exists to report.

The framework is symmetrical, and this case is the proof.

In the papal study, a forger closed a conveyancing gap and the document he wrote helped depose an emperor three centuries later and assign a hemisphere seven centuries later. In the Templar study, a Grand Master stopped bishops taxing his farms and thereby ensured that nobody on earth would have standing to defend his order. In both, the outcome ran far past the architect and ran downward.

Here it ran the other way, by exactly the same mechanism. Colbert wanted a better map of France for taxation and a better fix on longitude for his navy. To get them he assembled the most concentrated measuring capability in Europe, put it on the public payroll, gave it instruments, and maintained it. The knowledge it produced went everywhere immediately, because knowledge does — one of his numbers was in English hands within eighteen months and became a component of the theory that made his own country's

physics obsolete. The capability stayed, because capabilities do. It outlived him by a hundred and ten years, outlived the monarchy that created it, survived its own abolition by a republic that had correctly identified it as a royal instrument, and was the reason there existed, in 1791, a body of men who could be asked to measure the size of the earth and who knew how.

The metre is the product of the Académie des Sciences and it is not Colbert's achievement. He did not intend it, could not have conceived of it, would not have understood the reasons for its design, and would have been appalled by the government that commissioned it and by the deliberate decision to define it so that France could not own it. He is not owed the credit, and this is where the collection's standing rule takes its second and less comfortable form.

Legibility is not pardon: showing that the forger's document followed from his position does not excuse the fraud. And **legibility is not credit**: showing that the metre followed from Colbert's capability does not make him its author. The same fact grounds both — that a man in a chair can see the problem in front of him and cannot see, and cannot govern, what the thing he builds will meet after he is gone. That fact is morally neutral. It distributes blame no more than it distributes praise, and a method that used it only to deflate would be using it dishonestly.

What the case adds to the collection is a correction of emphasis, and it is worth stating as plainly as the rest.

The other studies could leave a reader with the impression that institutions reliably decay — that the architect's hour is always followed by drift into something worse. That is not what the framework claims and it is not what the record shows. Institutions *diverge* from their founders. The direction of the divergence is set by what the structure meets: by whether the capability it embodies turns out to be useful to good purposes or to bad ones, by who holds it next, and by what the world happens to need from it a century later. The Donation met a reform papacy looking for weapons. The Templar exemption met an insolvent king. Colbert's observatory met a revolution that needed the earth measured.

The most durable thing in this story is not a man and not a plan. It is a room full of instruments and the people trained to use them — bought by a finance minister who wanted to know how big his country was, and still being used, two centuries after his purposes had ceased to exist, to tell everyone else how big theirs are.

Held, like everything in this project, as tested, not revealed.

A Note on Sources

This is a work of synthesis, and every quotation and figure has been verified to a published source; none is invented. Where the scholarship is divided, the division is reported.

On the institution generally. The standard scholarly history is Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803* (University of California Press, 1971), which remains the point of departure for all subsequent work; David J. Sturdy, *Science and Social Status: The Members of the Académie des Sciences, 1666–1750* (Boydell, 1995), supplies the prosopography. The Academy's own historical account, and the *Encyclopédie* article of Diderot and d'Alembert on the Académie Royale des Sciences, are used as indicated. Ken Alder, *The Measure of All Things* (Free Press, 2002), is the standard narrative of the meridian survey and is relied on in Part XI.

On the founding. The first meeting of about sixteen scholars on 22 December 1666 in the King's library in the rue Vivienne, the assignment of two rooms and the twice-weekly working meetings, and the fact that the Academy operated for its first thirty years without statutes or regulations, follow the Academy's own history, the Institut de France, and the standard literature. Colbert's selection of the membership by discipline — astronomers, mathematicians and physicists on one side, anatomists, botanists, zoologists and chemists on the other — and the inclusion of Picard, Auzout, Roberval, Claude Perrault and Colbert's physician Cottereau du Clos, follow the same sources. The dissolution of the Montmor academy in 1664 and the suggestion by some of its members of a royal body follow the standard accounts. Colbert's preference for formal institutions under royal protection over informal private gatherings, and his pragmatic and goal-directed rather than curious approach to natural philosophy, are the settled judgment of the historians of the institution.

On Colbert and the fiscal and commercial landscape. Mazarin's death in March 1661, Louis XIV's assumption of personal rule, Fouquet's arrest, and Colbert's rise follow the standard histories of the reign. The structure of French taxation and the exemptions of the nobility and clergy are treated in detail in this collection's companion volume *Exempt* and follow the sources cited there. The Dutch commercial predominance of the mid-century, the Navigation Acts, and the mercantilist framework within which Colbert operated follow the standard economic histories; the characterisation of mercantilism as treating bullion as fixed and trade as zero-sum is the conventional summary and is contested in its details by economic historians who emphasise its variety.

On the recruitment. Huygens's arrival from The Hague in 1666 on a pension of six thousand livres, and the observation that he negotiated his terms at considerable price, follow the French archival and Academy sources. Cassini's recruitment — Picard's recommendation to Colbert; Colbert's 1668 proposal that he come for a limited period; the terms of nine thousand livres annually, free lodging and a travel allowance of a thousand écus; the authorisation by the senate of Bologna and by the pope for a limited stay with his Italian titles and emoluments retained; and his departure from Bologna on 25 February 1669 — follow the *Dictionary of Scientific Biography* article reproduced at Encyclopedia.com and the standard Cassini literature. His subsequent forty-three years in Paris, his directorship of the Observatory, the

discovery of Iapetus, Rhea, Tethys and Dione and their naming for Louis XIV, and the four-generation Cassini succession, follow the same sources. Ole Rømer's recruitment from Denmark in 1672 and his determination of the finite speed of light from Cassini's tables of the eclipses of Jupiter's satellites follow the standard accounts; the attribution of the calculation as between Rømer and Huygens is disputed in the literature and is not adjudicated here. The construction of the Observatory from 1667 on Claude Perrault's design, and the observation that its cost exceeded the budget of the Gobelins manufactory, follow the French archival material.

On the utility programme. The commissions in cartography, longitude, hydraulics and mechanics; the coastal survey by Picard and La Hire from 1679; the Cassini map of France, completed and published only in 1818; Richer's expedition to Cayenne in 1672 and the shortening of his pendulum near the equator; and the Academy's function in examining inventions and advising on privileges, follow the standard literature. The *Description des arts et métiers* is the Academy's own series. The judgment that Colbert's expected returns largely did not arrive on his timescale is this study's analytical claim, resting on the datings above.

On Picard and the arc of meridian. The survey of 1669–70 between Sourdon, near Amiens, and Malvoisine, near Corbeil, using thirteen triangles and Snell's triangulation method; Picard's application of the telescope to quadrants and sectors from the summer of 1667 and his use of a micrometer; his margin of error of about ten seconds of arc against Tycho Brahe's four minutes; his value of about 110.46 km per degree of latitude and the implied radius of about 6,328.9 km against the modern polar radius of about 6,357 km — follow the *Dictionary of Scientific Biography* article on Picard and the standard geodetic literature. The communication of Picard's method and result to the Royal Society on 11 January 1672 and publication in the *Philosophical Transactions* for 1675 follow the Newton Project's edition of Brewster. **The claim that Newton abandoned his gravitational speculations in the 1660s because of a defective value for the earth's radius and resumed them on learning of Picard's is contested**: it derives principally from Pemberton and from nineteenth-century biography, and the evidence indicates that Newton did not resume the moon problem until 1684 and did so following exchanges with Hooke and Halley. What is not contested, and is what this study relies on, is that Newton used Picard's value in the *Principia* with acknowledgement. The Cassini–Newton dispute over the figure of the earth and its resolution by the Lapland expedition of Maupertuis and Clairaut and the Peruvian expedition of Bouguer and Godin between about 1733 and 1744 follow the standard literature. The remark of Louis XIV on the coastal survey derives from Fontenelle's éloge of La Hire (1699), in which the king is reported to have observed that the journey had cost him nothing but loss, a loss that would enrich geography and secure navigation; the more familiar version comparing the academicians to his enemies is a later embellishment and is flagged as such.

On the Royal Society comparison. The formation of the Society in November 1660 and its charters of 1662 and 1663; its subscription funding, self-government and breadth of membership; and Henry Oldenburg's founding of the *Philosophical Transactions* in March 1665 as the first scientific journal, follow the standard histories of the Society. The observation that the Académie published nothing systematic before 1699 and that its early record is correspondingly thin follows the Linda Hall Library's account and the French bibliographical literature.

On the reorganisation of 1699. The règlement of January 1699, obtained by the abbé Jean-Paul Bignon through his uncle the chancellor Pontchartrain; the increase in membership from about sixteen to fifty; the classes of honoraires (ten), pensionnaires (twenty), associés (twenty, including foreign associates, Leibniz among the first) and élèves; the requirement of attendance and publication; the move to the Louvre;

and the confirmation by letters patent in 1713 — follow Joseph Bertrand's *L'Académie des sciences et les académiciens de 1666 à 1793*, the *Encyclopédie* article, the French archival material, and Marie-Jeanne Tits-Dieuaide's study of the renewal in the *Journal des savants* (1998). The publication statistics — some 3,400 papers in the *Histoire et mémoires* between 1699 and 1790 across roughly ninety-three volumes and fifty thousand pages, with pensionnaires as authors of 46 per cent, associés 23 per cent and adjoints 18 per cent, and a fifth of members never publishing — follow the bibliographical scholarship on the Academy's publications. The characterisation of the Academy's certification process as an ancestor rather than an instance of modern peer review is this study's analytical claim and is stated as such.

On the suppression and the Terror. The Convention's abolition of the academies on 8 August 1793; the creation of the Commission temporaire des poids et mesures républicaines with substantially the same membership; Lavoisier's arrest in November 1793, the commission's petition for his release, the Committee of Public Safety's response in purging five further members including Delambre, and Lavoisier's execution on 8 May 1794; Condorcet's arrest and death in March 1794; Delambre's exclusion from the work until June 1795; the creation of the National Institute of Sciences and Arts in 1795 and the reconstitution of the Académie des Sciences in 1816 — follow the standard accounts and the French metrological literature. **The remark that the Republic has no need of savants is traditionally attached to Lavoisier's trial and is not securely attested; it is flagged here as probably apocryphal and is not relied on.**

On the metric system. Talleyrand's proposal of 1790; the Assembly's reference of the question to the Academy in August 1790; the first commission's report of 27 October 1790 adopting a decimal scale; the second commission established on 16 February 1791, reporting on 19 March, with Lagrange, Laplace, Monge, Borda and Condorcet among its members; the Assembly's acceptance on 26 March 1791 of the quarter meridian as the basis; the rejection of the seconds pendulum, toward which international opinion had been converging in 1790, on the ground that a unit taken from nature excludes arbitrariness and belongs to no single nation; the 1791 decree's stated aim of extending the uniformity to foreign countries; the survey by Delambre and Méchain from June 1792 between Dunkirk and Barcelona; the provisional metre fixed by the law of 1 August 1793; the arrests, revoked passports and white signal markers mistaken for royalist colours; Delambre's completion of his section in 1797 and Méchain's arrival at Rodez in September 1798; the publication of the definitive value in Delambre's *Base du système métrique décimal* (1806–10); and the formal adoption of the metric system in France on 10 December 1799 — follow the French metrological literature, the arXiv survey of the history of the unit, and Alder. Méchain's concealed discrepancy in the Barcelona latitudes and his death in 1804 follow Alder. Lavoisier's descriptions of the mission and of the system are quoted from the standard accounts. The redefinition of the metre in terms of the speed of light in 1983 follows the standard metrological record.

On the costs. The exclusion of women, Marie Curie's rejection by two votes in January 1911 in favour of Édouard Branly, her election to the Académie Nationale de Médecine in 1922, Marguerite Perey's admission as a correspondent member on 12 March 1962, and Yvonne Choquet-Bruhat's election as the first woman full member in 1979, follow the Academy's own record, the *Annales* article on Curie's institutional recognition, and the contemporary accounts. The foundation of the Berlin academy in 1700 and the St Petersburg academy in 1724 on the Paris model follow the standard literature.

On the framework. The concepts of *position*, the *field of the visible*, *convergence*, the *architect's hour* and the *institution's logic* belong to the Patterns of Power project of which this paper is part and are developed across its studies, in particular *Position Logic* and *Against the Historian's Reflex*. The symmetric statement of

the collection's standing rule offered in Parts I and XIII — that legibility is not credit any more than it is pardon — is new to this volume and is offered as a correction to the collection's own emphasis. The controlled comparison in Part VIII follows the method used in *Exempt*. The observation that a successful institutional innovation destroys its own advantage by being copied is treated more fully in *The Composable Class*. Where this study's claims err, they should err visibly, in a form the cited scholarship can correct.

Part of the collection Patterns of Power. Tested, not revealed.